MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2 2016/2017

TRT 3241- REAL-TIME SYSTEMS
(All sections / Groups)

7ᵗʰ MARCH 2017
(9.00 a.m. – 11.00 a.m.)
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This examination paper consists of 5 pages (including the cover page) with 6 questions only.
2. All questions carry equal weight (10 marks). The allocation of marks for each section within a question is given in the paper.
3. Answer **ALL** questions.
4. Write your answers in the answer booklet provided.

Question 1 [10 marks]

a) Define a real-time system.

[2 marks]

b) Identify the key differences between hard real-time systems, soft real-time systems, and firm real-time systems.

[3 marks]

c) Define the following terms:
   i.   Performance constraint.
   ii. Behavioral constraint.

[2 marks]

d) Identify the timing constraints in the following air-defense system. Classify each constraint into either performance or behavioral constraint.

> *Every incoming missile must be detected within 0.2 seconds of its entering the radar coverage area. The intercept missile should be engaged within 5 seconds of detection of the target missile. The intercept missile should be fired after 0.1 seconds of its engagement but no later than 1 second.*

[3 marks]

Question 2 [10 marks]

a) Prepare a block diagram that shows the FOUR important hardware components of a real-time systems and their interactions. Explain the roles of the hardware components.

[4 marks]

b) A sensor is a device that outputs a signal which is related to the measurement of a physical quantity such as temperature and speed. Sensors can be classified into TWO types. Discuss each type.

[2 marks]

c) The following statements represent functional requirements of an aircraft monitoring system:

- The system shall perform various aircraft monitoring and recording functions.
- The aircraft has one engine fitted with pressure and temperature sensors.
- When three consecutive readings from each sensor were found to be out of range, a lamp corresponding to the sensor is changed from green to red.

Continued...

- A number of smoke detectors are installed in the aircraft. When smoke is first detected, an interrupt is generated by the smoke detectors.
- The system shall switch a smoke warning lamp from green to red when a smoke detection interrupt occurs.

Demonstrate the input and output components of the system.

[4 marks]

Question 3 [10 marks]

a) Discuss **TWO** problems of a centralized real-time control system.

[2 marks]

b) Describe **THREE** characteristics of real-time embedded systems.

[3 marks]

c) Discuss **TWO** arguments that advocate for language-based concurrency.

[2 marks]

d) Explain **THREE** types of information related to a task stored in the Task Control Block (TCB).

[3 marks]

Question 4 [10 marks]

a) Kernel is the smallest portion of the operating system (OS) that provides task scheduling, dispatching, and inter-task communication.

List **FIVE** levels of kernel hierarchy.

[2.5 marks]

b) Scheduling involves the allocation of resource and time to tasks in such a way that certain performance requirements are met. Several scheduling classes emerge, depending on:

  i.   Whether a system performs schedulability analysis.
  ii.   If it does, whether it is done statically or dynamically.
  iii. Whether the result of the analysis itself produces a schedule or plan according to which tasks are dispatched at run-time.

Based on this, discuss **FOUR** classes of scheduling algorithms.

[4 marks]

Continued...

c) Semaphore is an integer value used for signalling among processes. Discuss **TWO** criticisms on semaphore.

[2 marks]

d) Based on Lamport's algorithm, explain the situation when a multiprocessor is said to be sequentially consistent.

[1.5 mark]

Question 5 [10 marks]

a) Hatley and Pribhai have extended the data flow diagram model, proposed by DeMarco, in order to render it more suitable for the real-time environment. In addition to response time specification and a data dictionary, these extensions include the incorporation of two other types of system representation.

Explain the **TWO** other types of system representation.

[2 marks]

b) According to Yourdon Systems Method (YSM), models have **THREE** integrated viewpoints. Compile the viewpoints, and name the corresponding model(s) for each viewpoint.

[3 marks]

c) Consider the following hospital's patient monitoring system:

> *Each patient is connected to machines monitoring blood pressure, heart rate, and EKG. These machines issue a Boolean signal indicating a FAIL or NO FAIL condition. The results of each of these machines are Ord together to form a signal called ALARM. The ALARM signals for each of the rooms (one patient per room) are then Ord together and sent to the nurse's station. If any machine on any patient indicated a failure, the emergency alarm is sounded and the nurse is directed to the appropriate patient and machine.*

Compose a Petri Net representation for such a system.

[5 marks]

Question 6 [10 marks]

a) Discriminate between safety and reliability of a real-time system.

[2 marks]

b) Fault tolerance is the ability of the system to continue to function in the presence of hardware or software failures. Explain **THREE** levels of fault tolerance.

[3 marks]

c) Based on the following **FIVE** criteria, compare the key differences between N-Version programming and Recovery Block approach:
   i.   Redundancy.
   ii.   Design overheads.
   iii.   Run-time overheads.
   iv.   Error detection.
   v.   Atomicity.

[5 marks]

End of Paper.